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KEMLO'S

Watch-Repairer's Hand-book;

BEING

A COMPLETE GUIDE

TO THE

YOUNG BEGINNER IN TAKING APART, PUTTING TOGETHER, AND THOROUGHLY CLEANING THE ENGLISH LEVER AND OTHER FOREIGN WATCHES,

AND ALL AMERICAN WATCHES.

BY

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PRACTICAL WATCHMAKER.

WITH ILLUSTRATIONS.

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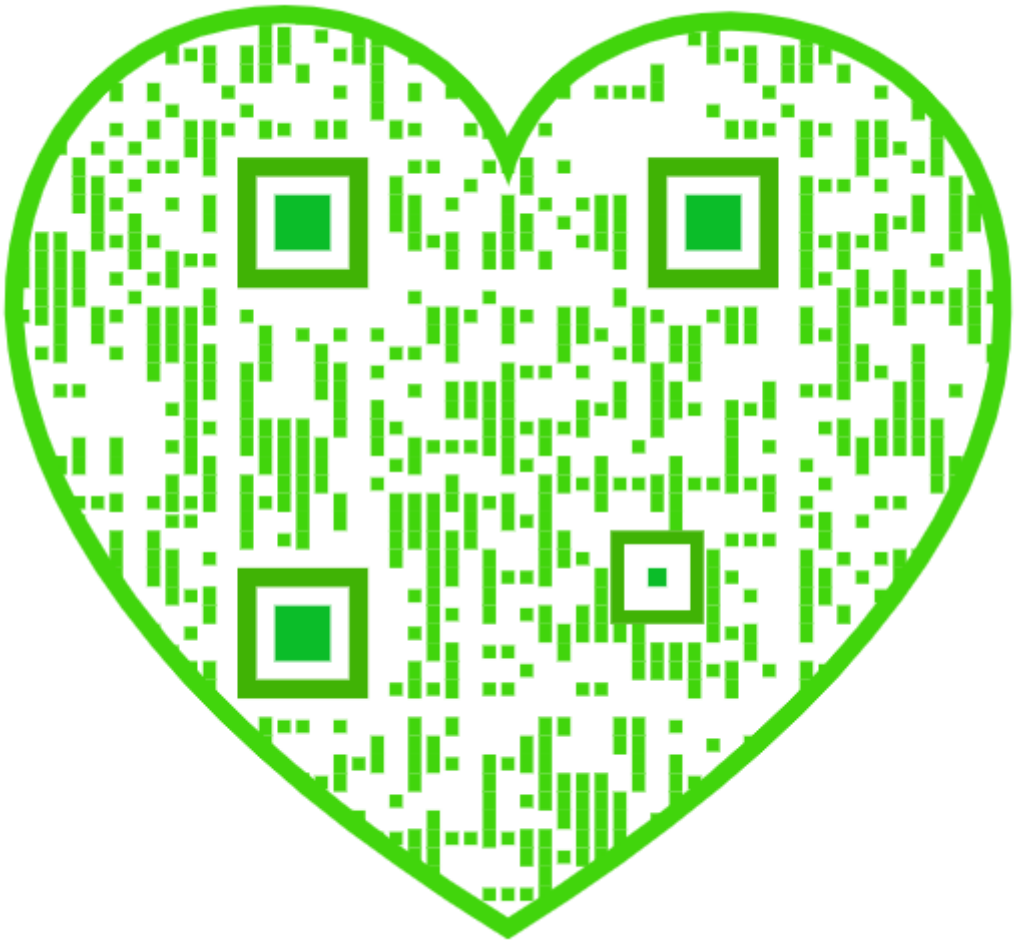

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PREFACE.

THIS Hand-book is designed to contain just such knowledge as every young watch-repairer, and every watch-owner would like to possess, expressed in few and clear words, and arranged in a systematic manner.

With it, with a few simple tools, and watch in hand, any one may readily learn the curious mechanism of his own watch. The young watch-repairer will need a master mechanic to guide and perfect his skill; but he will find this the book to study alone; by which to review his lesson, and prepare for more oral and hand teaching.

The watch-owner will better understand how to take care of his "bosom friend," and the necessity, in case of any derangement, of employing only the most skillful hand to restore it to order.

The articles on the construction of the watch, and the peculiarities of different styles, were prepared by skillful, practical workmen, and revised by the compiler. The English Lever, as the basis of all, and the most complicated of all, properly occupies the first place and the most space.

It can easily be seen that the American watch-maker,

if he will be honest and persevering, using the advantages that lie about him, must lead, not in cheapness only, but in simplicity and durability of mechanism. The prompt American business man must have the best watch, and his patriotism will make him prefer the home manufacture, if it be the best.

As our work is purely practical in its design, all reference to styles of watches made merely for fancy, or for some special purpose, is designedly omitted.

We are indebted to a popular work on Watches and Clocks, published by Haney & Co., New York, for the valuable tables, etc., introduced herewith.

HISTORY OF TIME-KEEPERS.

THE early history of the watch is involved in much obscurity.

It sprang from the clock. It is the clock without a bell, a time-keeping machine with a spring for its moving force, and a vibrating balance for a pendulum. It is a pocket clock; a *watchman* of time to be kept about the person; a portable indicator of the flight of the hours.

The *Sun-dial*, in some of its various forms, was, probably, the first method of marking the divisions of time. The uselessness of this by night and cloudy days must have been apparent.

The *Hour-glass*, with its "sands of time," came next. Scipio Nascia, 158, B. C., invented the *Water-clock* or *Clepsydra*, which was long in use. Some give Plato the credit of the first invention, 250 years before this.

Alfred the Great, whose wise reign extended from A. D. 871 to 900, knew nothing of any better time-keeper than a burning taper, each one marking a certain portion of the day.

The first attempts at the arrangement of wheel work with weights, so as to approach the idea of the modern clock, were probably made by the monks of the Middle

Ages. But the names of these "muttering monks" are obscured by the dim traditions of those times. Tower clocks and many private clocks were in use during the 14th and 15th centuries.

Tycho Brahé, who died in 1601, is said to have used a spring clock in his observations in astronomy; and we have reason to believe that many of these clocks were in use about this date.

Not far from this time the sage Galileo discovered the pendulum principle, which Huyghens, in 1656, applied to the clock, as a substitute for the balance.

Watches, but little resembling modern ones, probably, are said to have been invented in Nuremberg, about 1477, and were called *Nuremberg Eggs*.

Dr. Robert Hooke, a native of the Isle of Wight, is the accredited inventor, in 1658, of the spiral spring which regulates the balance, and gives watches their peculiar value as time-keepers. His claim is contested by the friends of Dr. Christian Huyghens, born at the Hague, who is the acknowledged inventor of the pendulum. But Huyghens' claim was not published before 1673, after Hooke's invention was well known.

Repeating watches were invented by Barlowe, in 1676.

John Harrison, of Yorkshire, Eng., made great improvements in watches between 1735 and 1776, the year of his death. His whole life was devoted to the work. The gridiron pendulum, and chronometers for determining longitude at sea, were his inventions.

Ferdinand Berthoud, born at Neufchatel in 1727, went to Paris in 1745, and died there in 1807. He made many improvements in the watch; but is particularly famed for

his marine chronometers. His pupil, Louis Berthoud, has made further improvements in these instruments, well known for accuracy among all navigators.

A. L. Breguet, born in 1747 at Neufchatel, succeeded by his talented son, ranks among the most eminent of modern horologists. His inventions embrace a wide range of acknowledged value among watch-makers.

George Graham invented the compensation pendulum in 1715, afterwards improved by Harrison. The invention of the horizontal or cylinder escapement is also attributed to him.

Fazio, a Genevan, introduced the art of boring rubies and other jewels, in which pivots revolve with little friction, about the year 1700.

Thomas Mudge is the inventor of the lever escapement. Among other distinguished English watch-inventors may be named Tompion, Dyzer, Arnold, Frodsham, Earnshaw, and Dent. Others among the Swiss and French, are Le Roy, Lepine, Chevalier, Courvoisier, and Preud'homme.

THE ENGLISH LEVER WATCH.

My plan is to take the English Lever Watch in its present form — to ask the reader to be seated in front of me at my work-bench, while I take it in pieces; describe all its parts; show how one part is connected with another; give the name of each piece as it is removed, and count the number of separate pieces of which the watch is made up. Having done this, I shall proceed to readjust all the parts, and restore our little machine to its former state of completeness and activity.

1. Take the watch out of the case by removing the joint pin. As the case is not an actual part of the watch, but merely a necessary covering to protect it, I do not count this one of the parts of the watch. Remove the three hands or pointers, namely, the second, minute, and hour hands — three pieces.

2. Take off the cap, by pushing the cap spring to the left by means of small screw in the center of the spring. This spring is removed from the cap by taking out the small screw in the center and pushing the spring further to the left, when it will fall off. The cap and spring are composed of the cap itself, the spring, with two steady pins, and a thumb-screw — five pieces.

3. Unscrew the cock and remove it from the top plate. The cock is the part that contains the top jewel work for the balance staff pivot to work in. It is secured to its place by a screw and three steady pins. This part complete, comprises the cock, three steady pins, cock screw, jewel hole, end-piece or diamond cap, and three screws to secure the jewel work in its place — ten pieces.

4. Take out the pendulum stud pin with the tweezers; draw the pendulum spring out of the stud; lift out the balance with staff, spring, and roller. The balance with pendulum spring, or hair-spring, as it is sometimes called, holds the same relation to the watch as the pendulum does to the clock, namely, that of a regulating medium. When in action, the outer end of the pendulum spring is held in the stud by the pin. The inner end is secured to a collet, called a pendulum collet, which fits tightly on the balance-staff collet. The pendulum collet, to which the pendulum spring is attached, is in the form of a loose collar, which admits of the spring being placed on the balance-staff, or removed from it at pleasure. A collet is used to join one or more parts together, and can be removed when required. This part complete, comprises balance, balance-staff with collet, pendulum collet, spring and pin, roller, and ruby pin — eight pieces. The roller with ruby pin fits tight on the balance-staff, and is the part which receives the impulse that gives motion to the balance.

5. Take off the fusee guard. This is a bit of round steel that fits over the winding-up square, to prevent the dust from the key getting into the fusee top hole. Sometimes this guard is made of brass in the form of a cup which comes through the cap — one piece.

6. Now take out the three brass edge feet pins which secure the brass edge and dial to the watch-movement; turn the watch over and remove the edge with dial. Some dials have a place sunk for seconds; some a sunk center for hour hand also; but a large number have the plain flat dial. So this will be considered as one piece only. Some watches have no brass edge, but a sunk back pillar plate which answers the same purpose; but by far the greatest number have the edge. This part complete, counts, dial, three dial feet pins, brass edge, three feet and three pins, joint with two rivets — fourteen pieces.

7. The watch is secured in the case by the brass edge joint. Remove the motion work from the pillar plate. This consists of the hour wheel, minute wheel and pinion, and cannon pinion. The latter fits on the center wheel back arbor, just sufficiently tight to carry the motion work and admit of the watch-hands being turned either backward or forward. This may be done without the least danger to the watch. The entire use of motion work, as it is called, is to give motion to the hour and minute hands.

The arbor is the pinion shaft; the pivots on the end of the arbor, or shaft, are what form the support for the wheels to work on. These count, hour wheel, minute wheel with small pinion in its center, cannon pinion, pin in center arbor to keep cannon pinion down — five pieces.

8. Let down the mainspring by holding the arbor firmly with bench-key or plyers, turning it carefully back, then press out the click from the barrel arbor ratchet teeth; these two hold the mainspring fast by its center. Take the ratchet off the arbor square; unscrew the click from the plate; also, unscrew the bolt and bolt spring from

their places. The bolt is to lock the watch in the case, and is the part pressed by the thumb-nail when the watch is opened out of the case. These parts collectively count, ratchet, click and screw, bolt and screw, bolt spring and screw — seven pieces.

Some watches have a stop work. These count, thumb-piece and screw, spring and screw, pin — five pieces.

The watch being now denuded of all the *outside* work necessary to be removed, I proceed to separate the frames, and lay bare all the internal wheel arrangement.

1. Unhook the chain from the barrel, then take off the name-piece, or barrel bar, by unscrewing the two screws by which it is secured to the top plate. These count, name-piece, two steady pins, two screws — five pieces.

2. Now lift the barrel from its place; take off the barrel cover or lid; lift out the barrel arbor. This arbor has a hook fixed in it; there is an eye in the inner end of the mainspring that this arbor hook goes into; this, with the click work that has been removed, holds the mainspring firmly in the center. The outer end of the mainspring has a hook attached to it, which fits in the rim of the barrel, and the act of winding up pulls the mainspring around with it, and coils it about the fixed barrel arbor. The effort which the mainspring makes to uncoil itself again, forms the motive power that gives motion to this beautiful miniature machine. Take the mainspring out of the barrel. These count, barrel with cover or lid, barrel arbor with hook, mainspring and hook — six pieces.

3. Take out the four pillar pins that bind top and pillar

plate together; raise the top plate a little on the pillar near the barrel space, this space being on the right hand; lift out the lever and pallets from their place between the plates. The top plate can now be entirely removed; this done, you see the wheels arranged in their respective places on the pillar plate; remove the pallet wheel, and the fourth wheel. Take out the detent, the fusee, center wheel, and third wheel.

The detent acts the part of a click. Its object is to hold the maintaining spring in action, which keeps the watch going during the process of winding up. It is kept in its place by the detent spring. If the watch is held to the ear for some time, every two or three minutes a click will be heard; this is the point of detent falling from one tooth to another on the detent wheel.

1. The watch being now emptied of its *wheels*, I will describe the *two plates with their attachments*. The parts that remain attached to the top plate are the regulator, two cap studs which the cap spring locks in pendulum stud, the stop work that gives the check when the watch is wound to the top, the pottence that contains the bottom jewel work for balance-staff pivot to work in, the chain guard pin. This pin is to prevent the chain, when it breaks, from striking against and breaking the balance-staff. The cock and pottence, the former outside, the latter inside the top plate, contain the jewel work and support the balance with its attachments in the watch. These collectively count, top plate, two cap studs, pendulum stud and pin, regulator with two pins, stop stud, stop pin to hold it in stud, stop spring and screw, chain guard pin,

two banking pins — fifteen pieces. This stop spring raises the stop from the plate; the chain presses it down as it winds up in the groove of the fusee; two banking pins form the stops to prevent the lever moving too far in its backward and forward motion.

2. The pottence is secured to the top plate by a screw and two steady pins. This part complete, counts, the pottence, screw, two steady pins, jewel hole, jewel slip — six pieces. The jewel slip contains a small stone that covers the back of jewel hole, and is what the end of balance-staff pivot works on; the diamond on the top of the cock is the stone for the end of top pivot to work on.

3. The pillar plate with the parts attached is the plate. The small wheel bar which is secured to the plate with two screws and two steady pins; the pin or stud that the minute wheel works on; detent spring and screw; four pillars and four pins, collectively count, with detent added, eighteen pieces. These four pins are only fixtures to hold the watch together.

Having given the name and number of pieces of all the *outside* work with the *frame of the watch*, I proceed to give the names, with number of teeth, of the various wheels; the number of their pinions, revolutions, &c.

1. The fusee is the part to which the mainspring first communicates its power. It is the most complicated of all the single parts that form the watch. The spring and other parts acting with it, and which are necessary to keep the watch going during the process of winding, are concealed in the fusee and may be described as follows: — First remove the chain, and take the hook out of the fusee

notch; take the fusee work in pieces by pressing out the collet pin, which holds it together when in action; take off the main wheel and detent wheel. The maintaining spring is concealed in the main wheel, and kept in its place by a steady pin. Another steady pin is fixed at the other extreme end of the spring, and this fits in the detent wheel. This wheel has two clicks and two springs fixed on to it. These clicks work in a ratchet wheel that is pinned fast on the fusee brass, and make the noise you hear when winding up, and prevents the fusee running back. When the power of the mainspring is exerted on the fusee, it winds up the maintaining spring a short space. The loose detent, which stands near the fusee, falls into the detent wheel teeth by the pressure of a spring; this keeps the detent work from running back when wound up by the mainspring. When working correctly it is sufficient to keep the watch going for fifteen minutes.

2. This fact has led some into error in this manner: A person winds up his watch, when, before it is returned to the pocket, a snap is heard. On looking at the watch the second hand is moving, and on listening, the beat is heard as usual; so it is returned to the pocket as all right. But on again referring to the watch, it is found to have moved only about fifteen minutes. This is thought to be strange; but the fact is, the snap was the breaking of the mainspring, and the watch was kept in motion by the detent work. This part complete numbers, fusee collet and pin, main wheel, maintaining spring, two steady pins, detent wheel, two clicks, two springs and four rivets, fusee ratchet, two rivets, fusee brass, steel square and cap, notch pin for chain to hook on — twenty-one pieces.

3. The fusee brass has a spiral groove cut in it to receive the chain. Where the mainspring is weakest it operates upon the larger diameter of the fusee; where the strongest, upon the less diameter, thus giving a uniform power throughout.

4. The main wheel on the fusee communicates motion to the center wheel; the center to the third wheel; third to fourth or seconds wheel; fourth to pallet or escapement wheel. This gives motion to the pallets and lever. The pallets of the lever watch work in the pallet wheel, and receive their backward and forward motion in a similar manner to the pallets of a clock, the former giving motion to a balance, the latter to a pendulum. The lever gives impulse to the balance through the roller that fits on the balance-staff.

5. The number of teeth in the main wheel, with the number in the center wheel pinion, determine the number of turns required to wind up the watch. It is desirable to effect this with as few turns as possible, in order to take a stronger chain. Different makers vary the count of this wheel and pinion, together with the number of winding-up turns; but the count in all the other wheels and pinions is a fixed number. In order, therefore, to put the matter as plainly as possible, I will call the main wheel seventy-five teeth, and the center pinion ten. This will give four turns in the fusee, or eight half turns to wind up the watch the full length of the chain. With this arrangement the watch will go thirty hours with once winding. The fusee will make one revolution in seven and a half hours.

6. The center wheel has sixty-four teeth, and makes one

revolution in an hour. The hour and minute hands are worked from this wheel.

7. The third wheel has sixty teeth, with a pinion of eight, and makes eight revolutions in an hour; this works the fourth or seconds wheel, which has fifty-six teeth, with a pinion of eight, and makes sixty revolutions in the hour. This wheel gives motion to the pallet or escapement wheel, which has fifteen teeth and pinion of seven. It makes eight revolutions in a minute, or four hundred and eighty in an hour.

8. The pallet wheel works on and gives motion to the pallets and lever. The pallets are jeweled in the part where the wheel acts upon them; so the pallet or escapement wheel works entirely on the stone, which is not subject to derangement from wearing away. The pallets receive from the wheel two hundred and forty separate impulses in the minute. The lever and pallets are both secured together on the staff; so that every impulse the pallets receive is communicated, at the same time, by the lever, to the ruby pin in the roller, which is fixed, as before stated, to the balance-staff.

1. The words "*Detached Lever*" are often put on the watch, either inside or on the dial. This means, that when the balance is driven off by the impulse it receives from the lever, all the work through the watch is locked dead, and remains so until the balance, on its return, causes the ruby pin in the roller to fall into the fork of the lever; when the momentum which the balance has acquired unlocks the escapement, and thus receives another impulse. It will be seen, therefore, when the lever has

given its impulse and driven the balance forward, the latter is disconnected entirely from all the other parts of the watch, and moves freely on its pivots in the jewel holes, and is only really connected with the other works in the watch during the short period of time required to give the impulse. All Detached Levers are, therefore, dead-beat watches.

2. The balance, as before stated, receives 240 impulses in the minute, or 14,400 in an hour, 345,600 in a day of twenty-four hours, 2,419,200 in a week, and 125,798,400 in the space of one year.

3. The balance of a Lever Watch varies in size with the different size of the watch; but to an ordinary sized Lever Watch the balance will be a little over two inches in circumference; but for the sake of even numbers I will call it two inches. Now, when the balance receives its impulse from the lever, it is driven about half a turn or revolution, say to the right; then the pendulum or hair-spring brings the balance back to receive another impulse, and be driven the same distance in the opposite direction. The balance being two inches in circumference, if sent half a turn in one direction, its rim or periphery will have travelled one inch through space. But it must travel over the same space again in coming back to the starting point, which will make two inches travelled over — the same taking place when sent in the opposite direction.

4. It will be seen at a glance, that in consequence of the balance motion being backward and forward, or an oscillating motion, it will travel over double the space it would do if it moved in one direction only. This being the case, the balance rim will move through two inches of

space for every impulse received. There being 240 impulses given in a minute, the balance rim will move over 480 inches of space in that time, or 28,800 inches in an hour, 691,200 in a day of twenty-four hours, 4,838,400 in a week. If the calculation is carried on, it will be found nearly 4,000 miles in the year. But, as two inches circumference is below the size of an ordinary Lever Watch balance, I will put it in round numbers at 4,000 miles, or equal to half the earth's diameter in a year. This calculation is made on the basis of the watch being a good one, with correct action.

Having said as much as space will permit of the various parts of the watch, I will finish counting up the number of pieces and give the sum total.

1. The FUSEE was the part last described and counted. The next in order of the train comes the center wheel and pinion, two; third wheel and pinion, two; fourth wheel and pinion, two; pallet wheel, collet, and pinion, three; pallets with two stones, three; lever with safety pin, also pin to secure pallets and lever together, three; pallet staff, one. These collectively count sixteen pieces. The safety pin is a small pin fixed near the end of the lever fork, where the ruby pin falls in to receive its impulse; this, with the banking pins, keeps the lever in position, and prevents the escapement getting out of action.

2. The WATCH CHAIN varies very much in length. This will be understood from the number of different sizes there are in Lever Watches, and the difference in the number of turns required to wind up these various instruments. The chain is made up of a number of small

steel links — three separate pieces, held by two rivets, to each link. These rivets in the fine chains are small as the finest end of the human hair; but their shortness constitutes their strength. However beautifully the watch may be made, and however correctly it may perform the part of a time-keeper, yet, if only one of these hair-like rivets gives way the watch is useless. Taking only a medium length of chain, in all its parts — links, rivets, and hooks — I shall be under the mark if I call their number *seven hundred.* I call these separate parts, because each and all are necessary. I might have made the number greater; because some parts which I have counted as one, are compound. Thus the dial is made up of a copper plate with three feet soldered on, the enamel in front, and the paint for figures. Here are six separate parts in this one, and others could in like manner be named; but I think the division which I have made is quite sufficient. Added together, these will give the number of *eight hundred* and *forty-five* (845) separate parts to make up the watch.

BEFORE CLEANING.

BRUSH the dust from all its different parts, and subject them to a careful examination with your eye-glass. Assure yourself that the teeth of the wheels and leaves of the pinions are all perfect and smooth; that the pivots are all straight, round and highly polished; that the holes through which they are to work, are not too large, and have not become oval in shape; that every jewel is smooth and perfectly sound; and that none are loose in their settings. See, also, that the escapement is not too deep or too shallow; that the lever or cylinder is perfect; that all the wheels have sufficient play to avoid friction, but not enough to derange their coming together properly; that none of them work against the pillar-plate; that the balance turns horizontally and does not rub; that the hair-spring is not bent or wrongly set, so that the coils rub on each other, on the plate, or on the balance; that everything about the whole movement is just as reason would teach you it should be.

TO CLEAN.

MANY watchmakers wet the pillar plates and bridges with saliva, and then dipping the brush into pulverized chalk or Spanish Whiting, rub vigorously until they appear bright. This is not a good plan, as it tends to remove the plating and roughen the parts, and the chalk gets into the holes and damages them, or sticks around the edges of the wheel-beds. The best process is to simply blow your breath upon the plate or bridge to be cleaned, and then to use your brush with a little prepared chalk. (See recipe for preparing it.) The wheels and bridges should be held between the thumb and finger in a piece of soft paper while undergoing the process; otherwise the oil from the skin will prevent their becoming clean. The pinions may be cleaned by sinking them several times into a piece of pith, and the holes by turning a nicely shaped piece of dry pivot wood into them. When the holes pass through jewels, you must work gently to avoid breaking them.

In oiling, avoid the too common fault of many watchmakers in using too much oil.

Some watchmakers employ what they call the "Chemical Process," to clean and remove discolorations from watch movements. It is as follows: —

Remove the screws and other steel parts; then dampen with a solution of oxalic acid and water. Let it remain a few moments, after which immerse in a solution made of one quarter pound cyanuret potassa to one gallon rain water. Let remain about five minutes, then rinse well with clean water, after which you may dry in sawdust, or with a brush and prepared chalk, as suits your convenience. This gives the work an excellent appearance, although no better than by the old process.

TO PREPARE CHALK FOR CLEANING.

Pulverize your chalk thoroughly, then mix it with clear rain water in the proportion of two pounds to the gallon. Stir well and let it stand two minutes. In this time the gritty matter will have settled to the bottom. Pour the water into another vessel slowly, so as not to stir up the settlings. Let stand until entirely settled, and then pour off as before. The settlings in the second vessel will be your prepared chalk, ready for use as soon as dried.

Spanish Whiting treated in the same way, makes a very good cleaning or polishing powder. Some operatives add a little jeweler's rouge. In cases where a sharper polishing powder is required, it may be prepared in the same way from rotten stone.

PITH FOR CLEANING.

The stalk of the common mullen affords the best pith for cleaning pinions. It may be found in old fields and by-places all over the country. Winter, when the stalk is dry, is the time to gather it. Elder pith is good, and is easily obtained

TO PUT TOGETHER.

I WILL now proceed to place all the parts of the watch together again, while they are still spread out before us on our work-bench.

1. In putting the *watch together*, first secure all the attachments or fixed parts to the two plates. Take the *pillar plate*, put on the small wheel-bar and screw it down; screw on the click, the bolt, and its spring. If there is a stop work to the watch, screw on the thumb piece and spring. Do the same with detent spring.

2. Take the *top plate* and put the winding stop in its stud, and pin it in; screw on the stop spring, put in the banking pins and chain guard pin. Screw on the cap studs; fix in the regulator, and see that the pendulum stud is secure. See that the jewel work is secure in the pottence; if so, screw it on the plate. It will be observed that there is a fine pivot at each end of the wheel pinions; these work in their corresponding holes in the bottom and top plate.

3. Take the *bottom* or *pillar plate* and put the third wheel in its place, with its pivot in the bottom hole. This wheel works under all the others, and so is put in its place first.

4. Next put in the center wheel. When the fusee has all its parts secured by the collet, place it in position and add the detent.

5. Now put in the fourth wheel, then the pallet wheel. This done, place the *top plate* on the pillars; but before it is pressed down into its proper place, raise it up a little on the pillar near the barrel space, as was done when taking the watch in pieces.

6. Now introduce the pallets and lever; place the bottom pivot of the staff in its hole on the *pillar plate.* This accomplished, slightly press the *top* and *pillar* plate together, guiding all the pivots into their respective holes in the *top plate.* Then press the plate into its proper position on the pillars and secure it there with the four pillar pins.

7. Wind the main spring into the barrel; put in the barrel arbor and cover or lid; introduce the barrel into its place in the watch, and put on the name piece or barrel bar and screw it down.

8. Now take the chain and put the largest hook into the small hole made in the barrel rim to receive it. Wind the chain on the barrel by means of the barrel arbor square; guide the end of the chain behind the pillars to the fusee; hook the end on the notch pin in the fusee; put the steel ratchet on the barrel arbor square. Wind up the spring about half a turn and press the click into the ratchet teeth. This click holds the spring from going back. All is now ready for the balance.

9. Take the balance, with its attachments as described, place it in position with the bottom pivot in the pottence jewel work; pass the end of the pendulum or hair-spring through the pendulum stud; draw it in until the ruby pin in the roller just falls dead on the back edge of the lever, and secure the spring in its stud with the stud pin. On

looking at the spring, when pinned in ready for action, it should present the appearance of a flat disc. Lift up the balance and introduce the ruby pin into the lever fork; place on the cock; guide the balance-staff top pivot into the cock jewel work.

10. This done, screw down the cock and set the balance in motion, which should be found equal, or in beat — that is, the beat or tick should sound uniform — meaning the impulse which the balance receives drives it an equal distance in both directions. Should it not be in beat, it can be made so by drawing in or letting out the hair spring, through the stud. Test it by placing a piece of peg wood, made thin and flat, on or in the teeth of the escapement wheel, and moving it forward. If in beat, the balance will move as far to the right as to the left.

11. See that the hair-spring stands free between the regulator pins. When they are *hard down* on the *slow* side, bring your regulator to the center.

12. Turn the watch over; place the cannon pinion on the center wheel back arbor, and put the small pin through the end to keep it down. Place the minute wheel on the pin or stud which is fixed in the plate; put the hour wheel on the cannon pinion. The teeth will work in the minute-wheel pinion; the cannon pinion drives the minute wheel.

13. Now place on the brass edge and dial, and secure them in place with the three brass edge feet pins; turn the watch round and put the guard on the fusee square. then put on the cap, and fasten it by pressing the cap spring to the right. Place the watch in the case, and put in the joint pin to secure it there; put the seconds hand

on its pivot, and then the hour and minute hands. Set them to the proper time. Finish winding up the watch.

Listen! Our merry little machine is busy at work again, and ready for his little nest in the pocket.

CONDITIONS NECESSARY TO SECURE A GOOD ENGLISH WATCH.

THE first consideration is to work upon these two all-important principles, namely, to lessen friction, and to secure soundness. The mainspring should be a good elastic spring, and work freely in the barrel, being just strong enough to do the work assigned to it. If it be too strong, it wears the holes too rapidly, and will endanger the safety of the chain.

The fusee pivots are the largest, the balance-staff pivots the smallest in the watch. All the other pivots should gradually decline in size from the largest to the smallest, and all should be polished in order to get smooth action. All the shoulders should be turned well off, to take away rubbing surface. If the pivots' shoulders are broad, and the oil bad or dirty, it will soon neutralize the power of the mainspring. If it is frosty weather the oil will stiffen on the broad shoulders and stop the watch.

All the works through the watch must be free, and no contacts made or allowed but what are necessary.

The wheels should not be thicker than requisite for the work to be done.

The pinions should be hard and well polished, so that

the wheel teeth can roll in and out of the pinions with as little rubbing as possible.

Care should also be taken to remove all bur or sharp edges from the wheel teeth.

The pallets must be well jeweled, and the stones stand a little flush above the steel, to prevent the possibility of the pallet wheel teeth touching anything but the stone. The wheel should not be thicker than the stones.

The escapement should be correctly sized and pitched, with no more lock on the escapement than necessary for safety.

The balance must be as heavy as the watch will bear to motion well; no watch can go regularly with a very light balance, but of course it must be proportioned to the size of the watch. Gold balances should be avoided; as they are liable to be affected by heat and cold.

The jewel holes in which the balance-staff pivots work, ought to be small and shallow; for, if they are too deep, the watch will be liable to go quicker when lying either on its back or face than when worn in the pocket or hanging up. The reason for this is, that when lying on its back or face the balance stands vertical, and the friction is on the pivot end; but when in the pocket or hanging up, the balance and staff are horizontal, and the friction is on the side of both pivots, and the friction is much greater than on the pivot end. Consequently when the least friction is operative, the balance will move more freely and to a greater distance than it will under the other condition.

The pendulum or hair-spring should be full, and the wire of uniform size or strength, so that the action will be equally distributed through the spring; and care must be

taken that one coil does not touch another. The least interference of anything with this very delicate spring will be fatal to the accuracy of the watch.

It ought to be borne in mind that a watch is simply a machine of very delicate construction, and that it is subject to the same conditions of wear and tear as other machines, only in a less degree. Some persons seem to think that a watch has been made upon an immortal principle, and not liable to those mutations to which other mechanical arrangements are subject. This is a mistake, and when it is considered what rapid action is constantly going on in this beautiful little machine, persons should not be surprised when they are sometimes told that the watch has needed some repairs. When we can produce a machine which is not subject to wear, we may then, indeed, claim to have a very close relationship with Deity.

THE SWISS WATCH.

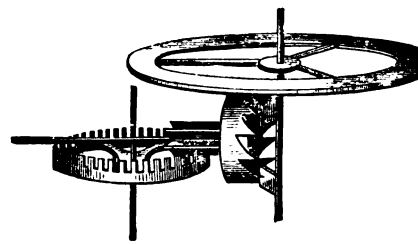
COMMONLY known as the Lepine, is made with both the lever and cylinder escapements. It was invented in France about half a century ago. In appearance it forms a striking contrast to both English and American watches. Instead of the two plates used in the former, it has only one, the wheels being held in position by means of bridges and cocks, which are screwed to the plate.

In taking a Lepine to pieces, the movement is taken from the case by turning a screw on the edge of the plate and resting on the lower rim of the case. The hands are removed in the usual manner, and the dial by turning the two screws which fit into the slots cut in the dial feet. The mainspring is let down by raising the ratchet on the barrel bridge. The balance and balance bridge to which it is attached, is taken carefully out, and the balance stud removed with a pair of pliers, or a knife, which is placed under the stud and gradually forced up. The pallets are taken out first; then the escapement, third, fourth, and center wheels, and barrel, in succession.

In putting together, place in the barrel first, then the fourth, third, center, and escapement wheels and pallets, in the order named. See that each wheel is free, or has the

proper end shake. Place in the balance, and set the watch in motion.

The Swiss, owing to the zeal with which they have long pursued their work, are not excelled by any people in the world in the perfection of their watches. They make all grades, from the cheapest to the most expensive; and their watches have been in universal demand throughout the world, for their moderate price and their excellence as time-keepers.



ESCAPEMENTS.

By these, watches get their distinctive names; in them lie, chiefly, the merits or defects of every watch. On them depend, more than aught else, other things being equal, the action of the whole machine — its regular movement, its safety, its durability.

1. The first watches, constructed as pocket time-pieces, had the VERTICAL ESCAPEMENT, which remained in use for over two hundred years, but are now nearly extinct, very few of them being in use, if we except some cheap ones manufactured in Switzerland, so inferior and inaccurate that even the advantage of cheapness may be doubted.

2. The LEVER ESCAPEMENT, in its original form, was invented by Berthoud, over a century ago; and, according to figures of it still in existence, is very like, in all except the position of some of its parts, the rack lever escapement, which was, at one time, extensively manufactured by Litherland, of Liverpool. But these were found objectionable on account of the intense friction caused by the con-

tact of wheel and pinion, and the dead friction on the pallets.

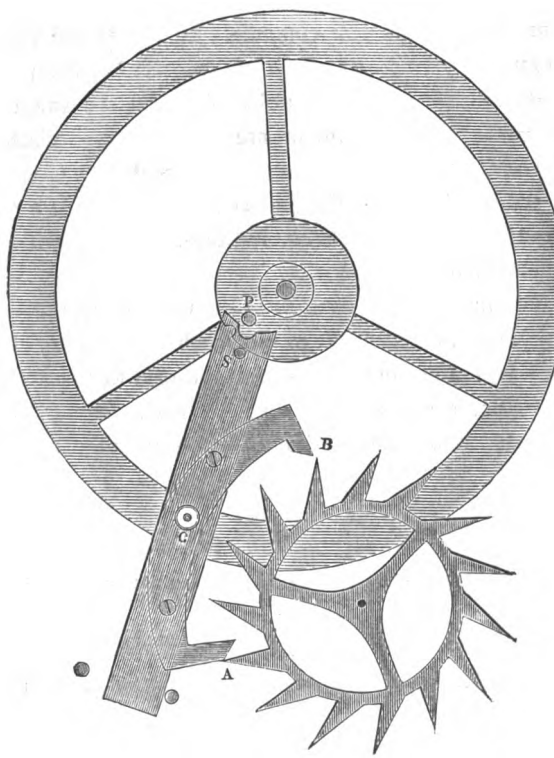
3. An improvement upon this was invented about thirty years afterwards by Mudge, and was known as the DETACHED LEVER, and now commonly known as the LEVER ESCAPEMENT. This is now in most general use; and nothing better seems attainable. All watches, wherever made, having this escapement, are called lever watches.

4. The CYLINDER ESCAPEMENT was invented by Graham. It is not considered as durable as the lever. It is manufactured mostly by the Swiss, and often performs with accuracy for many years.

5. The DUPLEX ESCAPEMENT is the most delicately constructed, and most difficult to repair when out of order. It is not adapted to rough usage. A fall or a knock, or violent motion, is apt to get it out of order. None but an experienced watch-maker should ever undertake to work on it.

6. The CHRONOMETER ESCAPEMENT is specially adapted to the marine chronometer, to which it is always applied. It is not adapted to the pocket-watch, or to any time-keeper liable to a variety of positions.

The perfection to which the *lever escapement* has been brought, of late years, renders its performance, when used with the compensating or chronometer balance, equally as precise as that of the chronometer. But the compensation balance should be used only when the other parts of the watch are perfect.



ENLARGED VIEW OF AN ENGLISH LEVER ESCAPEM

THE AMERICAN WATCH.

HISTORY OF AMERICAN WATCH-MAKING.

THE manufacture of watches by machinery, on the principle of uniformity of parts, by which every piece is an exact duplicate of the piece performing the same function in every other watch of the same grade, is due entirely to the ingenuity of the American mechanic.

Previous to the year 1850, the American public was supplied with watches of European construction — either the expensive English Lever with its complicated arrangement of fusee and chain, liable to become deranged, and exceedingly difficult of repair; or the more or less expensive Swiss or French watch, beautiful in form and finish, but, except in the case of high-priced watches, unreliable as a time-keeper, and, like the English Lever, expensive to keep in repair on account of the difficulty of replacing broken or damaged parts.

With the increase of business and population in the United States, and the extension of railroads, inducing habits of punctuality in business men, there came a demand for a time-keeper which should combine the accuracy of the higher grades of the English Lever and the cheapness of the Geneva watch. This end could not be attained under the methods of manufacture at that time,

and still in use in Europe; but it has been more than accomplished under the present system of American manufacture, by which watches are produced equaling in accuracy those made by Frodsham or Adams, and, not unfrequently, running for a year, through all the violent changes of weather peculiar to the New England climate, with a variation to be reckoned only by seconds; and doing this at a cost but little, if at all, exceeding that of the comparatively untrustworthy movement made in Geneva or Chaux-de-Fond.

This result is, in a great measure, due to the inventive genius of Mr. A. L. Dennison, a Boston watch-maker, who, in 1850, conceived the idea of manufacturing watches by machinery, on such a system that all parts of the watch should be made under one roof, by tools so nicely adjusted as to turn out work of almost perfect uniformity; and that each workman should be employed upon only one part of the watch, and should attain perfection in the construction of that part.

Mr. Dennison established a factory at Roxbury, Mass., which, after having been removed to Waltham, and having passed through several hands, was converted, under the management of Messrs. Robbins, Appleton & Co., into the American Watch Company, which, for many years, sent out nearly all the watches manufactured in this country. During this time, however, it has educated many workmen, who, having graduated from the parent factory, have furnished the skill necessary for the establishment of similar institutions elsewhere.

Among these are the Tremont Watch Company of Boston, Mass., and the Howard Watch Company of Roxbury, Mass.

Several factories have sprung into existence in other parts of the country, among which may be mentioned the National Watch Company of Elgin, Illinois; the United States Watch Company (Giles, Wales & Co.), of Marion, New Jersey, both of which are in successful operation, giving employment to a large number of skillful workmen in the various departments.

THE AMERICAN WATCH.

CONSIDERING the brief period during which the manufacture of watches has been carried on in this country, the perfection to which the higher grades of the American watch have arrived, is a matter of surprise. It has excited the wonder and elicited the encomiums of all who have given it fair trial.

Most of these watches are made with full or three-quarter plates. That its construction may be well understood, let one be taken apart upon our work table, each piece explained in detail, and then the whole put together again. I will take a *full plate movement with chronometer balance.*

I will commence by taking it from the case. This is done by turning the screw in the edge of the upper plate attached to the rim of the case. In some watches, for the sake of safety, the case screw is fastened in the pillar plate. It relieves the upper plate of a dangerous strain. Thus free, it can be easily pushed out. With the nippers, take off the three hands. The three brass pins in the dial feet are next taken out; the movement being turned with the bottom plate upwards, the dial is removed.

Next, the face wheels or motion work is taken off. These consist of the minute and hour wheels, and the can-

non pinion. The cannon pinion is fitted to the back arbor of the center wheel, and, when nicely done, is just tight enough to admit of being turned in either direction — that is, forward or backward, without injury to other parts of the watch. It also communicates motion to the hour and minute wheels. So far, ten parts of the watch are lying before me.

Attention is next given to the surroundings of the balance. First, the balance cock is unscrewed and taken off with a pair of tweezers. This part contains the jewel work, in which the upper pivot of the balance works. It is held in position by three steady pins and a screw. Taking this apart it is found to contain thirteen pieces, viz., the balance cock, three steady pins, screw, steel regulator, with two brass pins in the outer end, the jewel hole, the cap jewel, the steel cap into which it is fastened, and two small screws by which the jewels are held in place.

The next part to be looked after is the balance. This is taken from the watch by unscrewing the steel stud into which the hair-spring is fastened, and lifting it carefully out with a pair of tweezers. The inner end of the hair-spring is fastened to a small brass collet, which is attached to the upper shoulder of the balance-staff. It is so arranged that it can be removed at pleasure, as is often required when repairing the works. The balance is made of brass and steel — the inner circle of steel, and the outer of brass. It is fastened by fourteen small gold screws. By this arrangement the watch adjusts itself to varying temperature. I now count sixteen pieces in the balance; also, the hair-spring, hair-spring collet, hair-spring stud, with two steady pins, two brass pins securing the spring at

either end, the balance-staff, the roller and ruby pin fastened into the roller — in all, twenty-six parts.

Particular attention should be given in letting down the mainspring. This is done by placing a key firmly on the winding arbor and pressing the small brass pin which is in the end of the click, on the bottom plate toward the bridge, thus lifting it from the ratchet, and gradually letting it run down.

The barrel is next taken out by first unscrewing the bridge on the bottom plate, and removing the click, click spring, and ratchet. Next, the bridge on the upper plate, holding the main wheel in position, is unscrewed, and the barrel removed. This accomplished, the screws holding the upper plate to the pillar plate are taken out. The upper plate is then raised a very little to allow the pallets to be taken from between them. The upper plate can now be completely removed, exposing to view the entire inside arrangement, consisting of the escapement wheel, third wheel, fourth wheel and center wheel, which are taken out in the order named above.

All these parts of the American Lever watch make the sum total of one hundred and twenty (120) against eight hundred and forty-five (845) parts in an English Lever watch.

Having described the construction of an American full plate, exhibiting in order the different pieces contained therein, attention is next given to the manner in which the several parts are replaced so as again to make one whole.

TO PUT TOGETHER.

First, take the bottom plate, and put in its place the center wheel ; then the fourth, which carries the second hand ; then the third ; and, lastly, the escapement wheel.

This accomplished, place the top plate on the pillars. But, before pressing it into position, raise it a little, and put the lever and pallets in their proper places. Now, the plates can be pressed together, at the same time guiding the pivots into their respective jewel holes.

Having secured the plates in position, place in the four screws and fasten the top to the pillar plate.

The barrel is next placed in, and the top bridge screwed down.

Then turn the watch with the bottom plate uppermost, and put on the ratchet, click, and spring, and screw on the bottom bridge.

The cannon pinion is now put on the center shaft, and the minute and hour wheels put in their respective places. The dial is put on and fastened with the three brass pins.

The watch is now turned with its face downwards, and the balance placed so that the jewel pin in the roller will fall into the fork in the lever.

The balance spring stud is next screwed in place, and

the bridge put over the balance, guiding the pivot carefully into the jewel hole at the same time.

See that the spring plays equally between the pins of the regulator, as this will insure a nicer adjustment in the regulation. Put on the hands, then place it in the case.

The watch being together again, may now be wound up and set in motion.

WALTHAM WATCHES.

LADIES' WATCH.

PECULIAR ADVANTAGES CLAIMED FOR THE AMERICAN WATCH.

TAKING a Waltham Watch as an example, we find that it differs from the English Lever in many essential respects, some of which we will proceed to examine.

1. The watch movement, so called, is entirely independent of the case, in which it is held only by a pin and screw, and from which it can be removed at once by simply turning the screw, known as the case screw. In consequence of the perfect uniformity of size which is peculiar to American watches, the making of cases has become a separate branch of manufacture. They are made in factories in no way connected with that in which the movement is produced; and each case fits every watch of American make of the same grade and style. The advantage of this is obvious.

2. We find an important difference in the application of the motive power of the mainspring. Instead of the complicated mechanism of the fusee and chain, with its liability of derangement and breakage, the power from the mainspring is transmitted directly to the train, and through it to the escapement and balance, by a toothed wheel which forms part of the barrel, and gears into the pinion

of the center wheel. Thus we obtain a more economical and direct use of the power of the spring, and greatly reduce its thickness and stiffness, and consequent liability to break.

Experience has taught the watch-making world that there are about four turns of the mainspring in "going-barrel" watches in which the force is sufficiently uniform, when used in connection with stop works and the detached lever escapement, to insure the nicest adjustment to time, and satisfy the requirements of even our fastidious American public. Thus, by a simple arrangement and the use of *twelve* strong and durable component pieces, the same end is effected as by the frightful array of *seven hundred and twenty-one* in the chain and fusee of the English Lever.

The movements made by the various watch companies of this country, admit of their being removed from the barrel, in case of breakage of the spring, without taking apart the watch; — simply by taking off the barrel-bridge, the ratchet and click being retained in their place, and not requiring to be removed. In the Waltham movement, the cumbrous cap of the English Lever is substituted by a simple ring cap, which requires no fastening, but slips readily into all the cases now in use, and effectually protects the movements from dust. With these exceptions the process of taking down and putting together the American watch is substantially the same as that described in the preceding pages on the English Lever. When, however, the watch-maker is called upon to repair an American watch, the process is essentially different from that required by the watch of foreign manufacture. In that case, supposing any portion of the watch to be broken or defective, it be-

comes necessary to make from the rough material, by hand, as near an imitation as possible of the part needed. But, especially in the hands of the novice, much time is consumed in this process; and even if the watch is not permanently injured, as is often the case, the result is at best unsatisfactory, on account of the lack of those conveniences possessed by the manufacturer.

But our watch-maker has only to send the name of the defective part to the manufacturer or his agent, and he will receive, by return of mail, an exact duplicate made on the same machine as the original piece, and fitting readily in its place without any further trouble on his part. This, then, is the respect in which the American watch differs most essentially from all other watches, and in which, perhaps, its chief excellence consists — that the parts are made with such exactness and uniformity that each can be readily replaced, and that regularity of motion is produced which is impossible in watches not made by machinery.

It is not our purpose to depreciate the English Lever watch, which deservedly stands at the head of all *hand-made* watches. It is well worthy of the pride of the English manufacturer, and the praise of its admirers; but its cost places it out of the reach of the masses of the people, for whom the American system of watch-making has produced a reliable time-keeper and a cheap one.

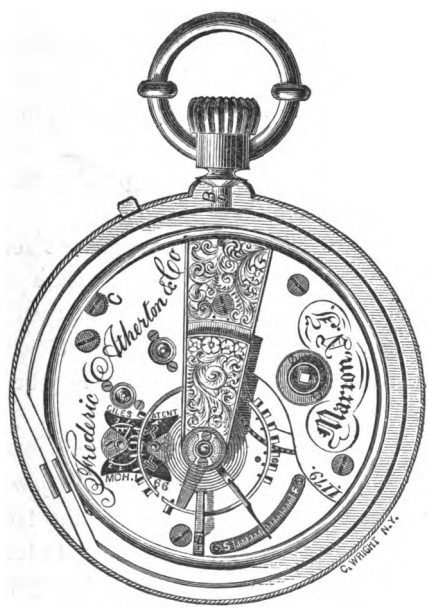
THE UNITED STATES WATCH COMPANY.

THIS Company was organized in 1867, and their manufactory is located in Marion, New Jersey. Messrs. Giles, Wales, & Co. are the proprietors. Salesrooms, 13 Maiden Lane, New York. Their watches are considered fully equal, in every respect, to those made by the New England manufacturers. As they differ somewhat in construction from those already described in the preceding pages, a description of their movements is necessary, to make our little hand-book complete.

The escapements of these watches are the "straight line Lever," with what is known as *visible* or *exposed* pallets — the patent double crescent opening in the plate, showing the entire action of the pallets on the escape wheel. This is of great advantage, not only to the young

beginner, but to the experienced workman — enabling them to look directly on the escapement, and immediately detect anything that may be wrong or out of place in that most sensitive part of the watch, and to observe the depth of the "lock," which is an essential feature in attaining correct performance as a time-keeper.

TO TAKE THE WATCH FROM THE CASE (IF A PENDENT WINDER).



1. Take out the screw (*B*), which is seen in the neck of the pendent; this releases the winding arbor, which is then removed.

2. On opening the glass bezel, a small screw will be seen in the rim of the case, passing into a slot in the *pusher* (*A*) for setting the hands. Turn out this screw, releasing the pusher, which may then be removed.

3. Turn the case or segment-headed screw (*C*), so that no portion of it remains over the edge of the case; then take out the movement.

4. Remove the hands and dial.

5. If the watch is wound, let the spring down carefully by firmly holding the key with one hand and pressing the click back from the ratchet with the other hand.

6. Turn out the cockscrew and remove the cock.

7. Turn out the screw in hair-spring stud, and remove that and the balance.

8. Turn out the two pillar screws passing through the barrel ridge, and remove that.

9. Then turn out the remaining two pillar screws, which leaves the top plate free to come off. Care should be taken in removing this that the fork end of the lever next the balance staff is turned to the right, sufficiently to let the pottance pass it; otherwise the pivot may be broken.

TO SET UP THE WATCH.

After carefully placing the pivots in the jewels in the pillar plate, turn the head or fork end of the lever to the right, before putting on the top plate, so as to let the pottance pass down by it. Then turn it to its proper position in the pottance. Great care should be observed in pressing the top plate to its position. If held too firmly, before the pivots are in their proper positions to enter the holes, there is danger of breaking or straining them.

If from any cause it should be found necessary to take out the banking screws, carefully notice the *lock* of the escapement before so doing; and in replacing them, be sure they occupy the same position as before removing. This is very important.

SELECTING A WATCH.

1. If you wish to be "in time" at the cars, the church, the school, the bank, or anywhere else; if you want the name of a punctual boy or man, you want a reliable time-keeper.

2. This is seldom found in a very cheap watch; sometimes not in a high-priced one.

3. If you do not know a good watch, no printed directions can help you much.

4. Your best way is, find a watch-maker or dealer of known ability and integrity. Trust him implicitly. Hold him accountable for his pledges.

5. Tell him whether you want a heavy watch or a light one; for business, or a lady.

6. Tell him how much money you can afford to spend, and how much of it you want in fancy. If you mean business, nothing for fancy. All good watches look well. Some bad ones do.

7. It is of no use to contract that the watch shall run well one year. Many inferior ones will do this and more.

8. If you prefer the chronometer balance, isochronal spring, and full ruby jewels, you may suggest this. But they must go with other first-class work.

9. You find first-class watches, English, Swiss, and American.

10. In a first-class American, you will get the time, simplicity of structure, less liability to get out of order, and most easily to put in order.

11. Never buy very small watches, unless you are willing to sacrifice accuracy for fancy; and always buy of watch-makers who know and will warrant the article they sell you.

12. I suggest no more than this. To an honest and skillful man in the business, you need suggest no more. Perhaps less. Trust him where you cannot trust yourself.

CARE OF THE WATCH.

1. Do not make a toy of it for yourself or the children. Never open it except for necessary purposes.

2. It should be regulated to about mean temperature, and always kept as near the same temperature as possible.

3. It should not be allowed to stop. Better that it be kept running all the time.

4. Keep it in as uniform position as possible. If in the pocket, better that the pendant ring be upright.

5. Out of pocket, if it hang on the wall, let it be upon some soft surface. Never allow it to lie on bare marble or other hard surface. If it lie on any surface, let it be with face up, and pendant ring turned under, so as to keep the upper part most elevated.

6. Let your key fit exactly, and be kept perfectly clean. By the former, you may save breaking chains, mainsprings, ratchets, clicks, etc.; by the latter, prevent introducing much dust.

7. Wind, if possible, at the same hour each day.

8. While winding, hold your watch steadily in your left hand. Turn only your key, and that firmly, evenly — avoiding all quick motion or jerks.

9. Set your watch with a key; never turn the hands by any other way. You may turn the hands either way without danger, if they do not move hard.

10. On regulating a watch, should it be going too fast, move the regulator a trifle towards the "slow," and if going slow, do the reverse; you cannot move the regulator too gently at a time, and the only inconvenience that can arise is, that you may have to perform that duty more than once.

11. Take note that your watch, even if a good one, will sometimes be guilty of "irregularities" in consequence of change of temperature, from the effects of which none but a chronometer is exempt; also, from the jerks and jars of travel.

12. If you find any difficulty which you do not understand, go at once to a good watch-maker.

WATCH-REPAIRING.

5

WATCH-REPAIRING.

I SHALL not attempt to describe, or to prescribe for, every species of defect that has been known to occur in a watch, for many of the defects constantly to be met with, are of a character so simple that any person of ordinary ingenuity will be able to observe them at once and apply the remedy. Such, for instance, as *putting in a mainspring, a hair-spring, or a jewel.*

With a view, however, to give the young watch-maker the requisite information to enable him to go to work understandingly, I will proceed to offer such modes employed in watch-repairing as he would not easily acquire himself, without some assistance from one experienced in the trade.

TO PIVOT.

When you find a pivot broken, you will hardly be at a loss to understand that the easiest mode of repairing the damage is to drill into the end of the pinion or staff, as the case may be, and having inserted a new pivot, turn it down to the proper proportions. This is by no means a difficult thing when the piece to be drilled is not too hard, or when the temper may be slightly drawn without injury to the other parts of the article.

TO DRILL INTO HARDENED STEEL.

For this purpose make your drill oval in form, instead of the usual shape, and temper as hard as it will bear without crumbling. Roughen the surface of the object into which you desire to drill with a little diluted nitric acid. Start your drill, and to prevent it from becoming heated use spirits of turpentine instead of oil. When your drill begins to run smooth in consequence of the bottom of the holes becoming burnished, clean out the turpentine and roughen again with acid ; then proceed as before.

You will find this a somewhat tedious business, but with a little patient application you will finally be able to accomplish your object. It is the only mode for drilling into highly tempered steel that will work with any degree of certainty.

TO TELL WHEN THE LEVER IS OF PROPER LENGTH.

You may readily learn whether or not a lever is of proper length, by measuring from the guard point to the pallet staff, and then comparing with the roller or ruby-pin table ; the diameter of the table should always be just half the length measured on the lever. The rule will work both ways, and may be useful in cases when a new ruby-pin table has to be supplied.

TO LENGTHEN LEVERS OF ANCHOR ESCAPEMENTS.

Cut across with a screw-head file, just back of the fork, as deeply as you can with safety. The thin point thus left standing to itself you will bend gently forward to the proper position. This is all that will be required. If you should break the little point in your efforts to bend it, —a thing

not likely to happen — you can file down level, drill a hole, and insert a pin, American lever style.

TO CHANGE DEPTH OF LEVER ESCAPEMENT.

If you are operating on a fine watch, the best plan is to put a new staff into the lever, cutting its pivots a little to one side — just as far as you desire to change the escapement. Common watches will not, of course, justify so much trouble. The usual process in their case is to knock out the staff, and with a small file cut the hole oblong in a direction opposite to that in which you desire to move your pallets; then replace the staff, wedge it to the required position.

In instances where the staff is put in with a screw, you will have to proceed differently. Take out the staff, pry the pallets from the lever, file the pin holes to slant in the direction you would move the pallets, without changing their size on the other side of the lever. Connect the pieces as they were before, and with the lever resting on some solid substance you may strike lightly with your hammer until the bending of the pins will allow the pallets to pass into position.

TO TELL WHEN THE LEVER PALLETS ARE OF PROPER SIZE.

The clear space between the pallets should correspond with the outside measure, on the points, of three teeth of the scape wheel. The usual mode of measuring for new pallets is to set the wheel as close as possible to free itself when in motion. You can arrange it in your depthing tool, after which a measurement between the pivot holes of the two pieces, on the pillar plate, will show you exactly what is required.

TO PUT TEETH INTO WHEELS.

Make a hole through the plate of the wheel immediately below the point from which the tooth has been broken. Let its diameter be a little greater than the width of a tooth. Next, with your tooth-saw, cut down where the tooth should stand till you come into the hole. You then dress out with a head upon it, a piece of brass wire, till it fits nicely into the cut of the saw, with its head in the hole. With a fine graver you then cut a crease into the wheel-plate above and below, on either side of the newly-fitted wire; after which, with your hammer, you cautiously spread the face of the wire until it fills the creases, and is securely clinched or riveted into the wheel. This makes a strong job, and one that dresses up to look as well as any other.

TO WEAKEN THE HAIR-SPRING.

This is effected by grinding the spring down. You remove the spring from the collet, and place it upon a piece of pivot wood cut to fit the centre coil. A piece of soft steel wire, flattened so as to pass freely between the coils, and armed with a little pulverized oil-stone and oil, will serve as your grinder, and with it you may soon reduce the strength of the spring. Your operations will, of course, be confined to the centre coil, for no other part of the spring will rest sufficiently against the wood to enable you to grind it, but this will generally suffice. The effect will be more rapid than one would suppose, therefore you will watch carefully or you may get the spring too weak before you suspect it.

Another and perhaps later process is as follows: Fit the

collet, without removing the spring, upon a stick of pivot wood, and having prepared a little diluted nitric acid in a watch glass, plunge the centre coils into it, keeping the other parts of the spring from contact by holding it in the shape of an inverted hoop skirt, with your tweezers. Expose it a few seconds, governing the time of course by the degree of effect desired, and then rinse off, first with clean water, and afterwards with alcohol. Dry in the sun or with tissue paper.

TO PREVENT A CHAIN FROM RUNNING OFF THE FUSEE.

In the first place you must look after and ascertain the cause of the difficulty. If it results from the chain's being too large, the only remedy is a new chain. If it is not too large, and yet runs off without any apparent cause, change it end for end — that will generally make it go all right. In cases where the channel in the fusee has been damaged, and is rough, you will be under the necessity of dressing it over with a file the proper size and shape. Sometimes you find the chain naturally inclined to work away from the body of the fusee. The best way to remedy a difficulty of this kind is to file off a very little from the outer lower edge of the chain the entire length — this, as you can see, will incline it to work on instead of off. Some workmen, when they have a bad case, and a common watch, change the standing of the fusee so as to cause the winding end of its arbor to incline a little from the barrel. This, of course, cannot do otherwise than make the chain run to its place.

TO TIGHTEN A CANNON PINION ON THE CENTER ARBOR.

Roll the arbor between two files, letting the square part be to one side of them, of course. A very slight roll between two files will generally tighten the cannon, and there can be no danger of bending the arbor or setting the pinions to one side.

TO TIGHTEN A RUBY PIN.

Set the ruby pin in asphaltum varnish. It will become hard in a few minutes, and be much firmer and better than gum shellac, as generally used.

ON MENDING WATCH TRAINS.

WHEN a wheel or a pinion is wanting in the train of a watch, it is usual to say the train is broken; and the act of supplying that wheel or pinion is generally termed mending the train. This, according to the old plan of working, involved no small amount of labor, in the way of calculations, to get the proper size of the new piece. A person was under the necessity of being a good algebra scholar to do it. The recent, or I might say, the American system — for European watchmakers still hold to their old ways, — makes it much easier. A few simple tables have been gotten up by which any person who knows how to count and to measure may select the piece he wants in a few minutes.

TO DETERMINE THE REQUIRED DIAMETER OF A PINION.

For size of Pinion with	Measures on Wheel.	Character of Measure.
4 leaves, . . .	2 teeth, . . .	Very full from out to out.
5 leaves, . . .	3 teeth, . . .	Exactly from centre to centre.
6 leaves, . . .	3 teeth, . . .	Full from centre to centre.
7 leaves, . . .	3 teeth, . . .	Scant from out to out.
8 leaves, . . .	4 teeth, . . .	Scant from centre to centre.
9 leaves, . . .	4 teeth, . . .	Full from out to out.
10 leaves, . . .	4 teeth, . . .	Exactly from out to out.
12 leaves, . . .	5 teeth, . . .	Exactly from centre to centre
14 leaves, . . .	6 teeth, . . .	Scant from centre to centre.
15 leaves, . . .	6 teeth, . . .	Scant from out to out.
17 leaves, . . .	7 teeth, . . .	Full from centre to centre.

TABLES OF NON-SECOND WATCH TRAINS.

Centre Wheel.	3d Wheel and Pinion.		4th Wheel and Pinion			Scape Wheel and Pinion.		Beats per Minute.	Character of Trains.
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	
66	63	6	63	6	31	7	6	283 scant	Trains for seven teeth in scape wheel.
66	64	6	63	6	31	7	6	287 full	
66	64	6	64	6	31	7	6	292 full	
72	66	6	58	6	27	7	6	298 scant	
66	63	6	62	6	31	7	6	278 full	
66	63	6	61	6	31	7	6	274 scant	
66	63	6	60	6	31	7	6	267 full	
63	60	6	56	6	34	9	6	294 . .	Trains for nine teeth in scape wheel.
66	60	6	54	6	33	9	6	297 . .	
63	60	6	57	6	34	9	6	299 full	
66	60	6	53	6	33	9	6	291 full	
63	60	6	55	6	34	9	6	289 scant	
60	60	6	52	6	33	9	6	286 . .	
63	60	6	54	6	34	9	6	283 full	
66	60	6	51	6	33	9	6	280 full	
63	60	6	53	6	34	9	6	278 full	
63	60	6	52	6	34	9	6	273 . .	
66	60	6	50	6	33	9	6	275 . .	
58	56	6	53	6	40	11	6	292 full	Trains for eleven teeth in scape wheel.
64	52	6	52	6	30	11	6	294 scant	
60	56	6	52	6	30	11	6	230 scant	
60	60	6	49	6	36	11	6	300 scant	
60	54	6	54	6	40	11	6	397 . .	
60	54	6	53	6	40	11	6	291 full	
62	54	6	51	6	39	11	6	290 scant	
58	54	6	54	6	41	11	6	287 full	
58	55	6	53	6	41	11	6	287 . .	
59	54	6	53	6	41	11	6	286 full	
60	54	6	52	6	40	11	6	286 . .	
61	55	6	51	6	39	11	6	286 scant	
56	55	6	50	6	39	11	6	285 scant	
60	55	6	48	6	38	11	6	282 full	
62	54	6	52	6	41	11	6	281 scant	
63	54	6	51	6	40	11	6	281 full	
63	54	6	50	6	39	11	6	280 scant	
70	54	6	54	6	43	11	6	277 full	
70	60	6	48	6	36	11	6	293 full	
70	54	6	52	6	39	11	6	295 full	
60	54	6	50	6	38	11	6	289 scant	
63	48	6	56	6	43	11	6	287 full	

TABLES OF NON-SECOND WATCH TRAINS.

(Continued.)

Centre Wheel.	3d Wheel and Pinion.		4th Wheel and Pinion.			Scape Wheel and Pinion.		Beats per Minute.	
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	Character of Trains.
63	70	7	56	7	36	11	7	293 full	Trains for eleven teeth in scape wheel.
80	70	7	48	7	36	11	6	293 full	
80	60	7	48	6	36	11	6	293 full	
80	70	6	48	7	36	11	6	293 full	
80	50	6	56	7	40	11	6	287 full	
80	63	6	50	7	38	11	6	289 scant	
80	80	8	64	8	36	11	8	293 full	
70	80	8	56	8	36	11	7	293 full	
70	80	8	48	8	36	11	6	293 full	
63	56	6	56	7	40	11	6	287 full	
63	64	6	56	8	40	11	6	287 full	
84	48	8	56	6	40	11	6	287 full	
84	56	8	56	7	40	11	6	287 full	
84	64	8	56	8	40	11	6	287 full	
63	63	6	50	7	38	11	6	289 scant	
63	72	6	50	8	38	11	6	289 scant	
84	54	8	50	6	38	11	6	289 scant	
84	63	8	50	7	38	11	6	289 scant	
60	72	8	50	8	38	11	6	289 scant	
70	80	6	48	8	36	11	6	293 full	
70	80	7	48	8	36	11	6	293 full	
80	80	7	56	8	36	11	7	293 full	
80	60	8	48	6	36	11	6	293 full	
80	70	8	48	7	36	11	6	293 full	
80	70	8	56	7	36	11	7	293 full	
52	52	6	51	6	48	13	6	277 scant	Trains for thirteen teeth in scape wheel.
57	51	6	48	6	44	13	6	280 scant	
56	51	6	49	6	45	13	6	281 scant	
54	52	6	50	6	46	13	6	282 scant	
50	51	6	50	6	45	13	6	284 full	
54	43	6	50	6	45	13	6	287 full	
54	52	6	51	6	46	13	6	287 full	
57	53	6	48	6	43	13	6	291 scant	
56	54	6	48	6	44	13	6	291 full	
56	53	6	49	6	44	13	6	292 scant	
54	53	6	51	6	45	13	6	293 scant	
60	51	6	48	6	42	13	6	294 full	
59	51	6	49	6	43	13	6	296 scant	
56	53	6	50	6	44	13	6	298 scant	

TABLES OF NON-SECOND WATCH TRAINS.

(Continued.)

Centre Wheel.	3d Wheel and Pinion.		4th Wheel and Pinion.			Scape Wheel and Pinion.		Beats per Minute.	Character of Trains.
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	
54	53	6	52	6	45	13	6	298 full	Trains for thirteen teeth in scape wheel.
53	52	6	50	6	46	13	6	276 full	
52	52	6	52	6	46	13	6	293 scant	
55	51	6	51	6	46	13	6	287	
56	50	6	51	6	46	13	6	286 full	
56	52	6	48	6	44	13	6	280 full	
56	52	6	50	6	44	13	6	292 full	
60	48	6	48	6	45	13	6	277 full	
60	50	6	48	6	43	13	6	289 scant	
60	54	6	60	8	53	13	6	292 full	
60	58	7	56	7	51	13	6	287 full	
60	60	8	54	6	44	13	6	300	
62	56	7	56	7	47	13	6	396 full	
63	52	8	51	6	60	13	6	285	
63	60	8	60	7	60	13	6	290	
64	60	8	60	7	60	13	6	285	
72	70	8	68	8	60	13	6	280	
74	68	8	68	8	60	13	6	286 full	
48	45	6	56	6	50	15	6	288	Trains for fifteen teeth in scape wheel.
48	45	6	57	6	62	15	6	288	
48	45	6	58	6	62	15	6	300	
48	45	6	59	6	60	15	6	291 scant	
58	48	6	46	6	50	15	6	290	
54	50	6	48	6	48	15	6	286	
56	48	6	46	6	50	15	6	289 scant	
63	56	7	56	7	50	15	7	288	
60	56	8	58	7	50	15	6	288	
62	60	8	60	8	50	15	6	288	
72	64	8	50	8	50	15	6	288	
72	64	8	56	8	50	15	7	288	
72	64	8	64	8	50	15	8	288	
52	50	6	48	6	50	15	6	288	
54	48	6	48	6	50	15	6	288	
72	64	8	48	8	50	15	6	288	
72	80	8	64	10	50	15	8	288	
72	80	8	56	10	50	15	7	288	
72	80	8	48	10	50	15	6	288	

TABLES OF NON-SECOND WATCH TRAINS.

(Continued.)

Centre Wheel.	3d Wheel and Pinion.		4th Wheel and Pinion.			Scape Wheel and Pinion.		Beats per Minute.	
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	
63	80	7	64	10	50	15	8	288	Trains for fifteen teeth in scape wheel.
63	80	7	56	10	50	15	7	288	
63	80	7	48	10	50	15	6	288	
72	64	8	56	8	50	17	8	286 scant	Trains for seventeen teeth in scape wheel.
64	64	8	64	8	50	17	8	290 full	
48	48	6	45	6	53	17	6	272	
48	48	6	46	6	53	17	6	278	
64	80	8	48	10	53	17	6	299 full	
54	48	6	44	6	50	17	6	299 full	
51	48	6	45	6	53	17	6	295 full	
54	48	6	43	6	50	17	6	292 full	
48	48	6	48	6	53	17	6	290 full	
51	48	6	45	6	53	17	6	289	
54	48	6	42	6	53	17	6	286 scant	
48	48	6	47	6	53	17	6	284 full	
51	48	6	44	6	53	17	6	283 scant	
64	64	8	60	8	53	17	8	289 scant	
56	56	7	56	7	53	17	7	290 full	
63	56	7	49	7	53	17	7	286 scant	
64	56	8	48	7	53	17	6	290 full	
80	80	10	64	10	53	17	8	290 full	
80	64	10	64	8	53	17	8	290 full	
8c	64	10	56	8	53	17	7	290 full	
8c	64	10	48	8	53	17	6	290 full	
8c	56	10	56	7	53	17	7	290 full	
80	56	10	48	7	53	17	6	290 full	
64	80	8	64	10	53	17	8	290 full	
64	80	8	56	10	53	17	7	290 full	

TABLES OF FOURTH WHEEL SECOND WATCH TRAINS.

Centre Wheel.	3d Wheel and Pinion.		4th Wheel and Pinion.			Scape Wheel and Pinion.		Beats per Minute.	
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	
48	45	6	76	6	60	11	6	279 scant	Fourth wheel seconds with eleven teeth in scape wheel.
48	45	6	74	6	60	11	6	271 full	
48	45	6	71	6	60	11	6	260 full	
56	60	7	74	8	60	11	6	271 full	
48	75	6	78	6	60	11	6	286	
60	79	7	74	7	60	11	6	271 full	
60	79	7	76	7	60	11	6	279 scant	
60	79	7	78	7	60	11	6	286	
45	56	6	74	7	60	11	6	271 full	
45	56	6	76	7	60	11	6	279 scant	
45	56	6	78	7	60	11	6	286	
64	60	8	74	8	60	11	6	271 full	
64	60	8	76	8	60	11	6	279 scant	
64	60	8	78	8	60	11	6	286	
60	56	8	74	7	60	11	6	271 full	
60	56	8	78	7	60	11	6	286	
60	78	8	74	6	60	11	6	271 full	
48	78	8	78	6	60	11	6	286	
48	60	6	74	8	60	11	6	271 full	
48	60	6	78	8	60	11	6	286	
60	56	8	76	7	60	11	6	279 scant	
64	60	8	66	8	60	13	6	286	Fourth wheel seconds with 13 teeth in sc'pe w
64	60	8	67	8	60	13	6	290 full	
56	75	7	68	10	60	13	6	295 scant	
45	56	6	66	7	60	13	6	286	
60	49	7	66	7	60	13	6	286	
60	49	7	77	7	60	13	7	286	Fourth wheel seconds with thirteen teeth in scape wheel.
64	60	8	69	8	60	13	6	299	
64	60	8	68	8	60	13	6	295 scant	
60	49	7	67	7	60	13	6	290 full	
48	45	6	66	6	60	13	6	286	
48	45	6	67	6	60	13	6	290 full	
48	45	6	68	6	60	13	6	264 scant	
48	45	6	69	6	60	13	6	299	

TABLES OF FOURTH WHEEL SECOND WATCH TRAINS.

(Continued.)

Centre Wheel	3d Wheel and Pinion.		4th Wheel and Pinion.			Scape Wheel and Pinion.		Beats per Minute.	
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	
60	56	8	66	7	60	13	6	286	Fourth wheel seconds with thirteen teeth in scape wheel.
80	60	10	66	8	60	13	6	286	
64	75	8	66	10	60	13	6	286	
48	60	6	66	8	60	13	6	286	
48	75	6	66	10	60	13	6	286	
64	45	8	60	6	60	15	6	300	Fourth wheel seconds with fifteen teeth in scape wheel.
64	60	8	60	8	60	15	6	300	
64	64	8	70	10	60	15	7	300	
64	60	8	70	8	60	15	7	300	
60	56	8	60	7	60	15	6	300	
48	60	6	60	8	60	15	6	300	
60	70	7	70	7	60	15	7	300	
60	49	7	60	7	60	15	6	300	
48	49	6	60	6	60	15	6	300	
80	45	10	70	8	60	15	7	300	
75	60	10	60	8	60	15	6	300	
64	75	7	60	10	60	15	6	300	
56	75	7	70	10	60	15	7	300	Fourth wheel seconds with fifteen teeth in scape wheel.
56	75	8	60	10	60	15	6	300	
64	75	8	54	8	60	15	6	270	
60	60	8	54	7	60	15	6	270	
64	56	8	54	6	60	15	6	270	
48	45	6	54	8	60	15	6	270	
60	60	7	63	7	60	15	7	270	
60	56	8	48	7	60	15	6	240	
60	49	7	54	7	60	15	6	270	
48	49	6	54	6	60	15	6	270	
64	45	8	48	8	60	15	6	240	
60	60	8	48	7	60	15	6	240	
48	50	6	48	8	60	15	6	240	
64	60	8	48	6	60	15	6	240	
60	45	7	56	7	60	15	7	240	
60	49	7	48	7	60	15	6	240	
48	45	6	48	6	60	15	6	240	

TABLES OF FOURTH WHEEL SECOND WATCH TRAINS.

(Continued.)

Centre Wheel.	3d Wheel and Pinion.		4th Wheel and Pinion.			Scape Wheel and Pinion.		Beats per Minute.	
No. of Teeth in Wheel.	Teeth in Wheel.	Leaves in Pin.	Teeth in Wheel.	Leaves in Pin.	Seconds in Revolutions.	Teeth in Wheel.	Leaves in Pin.	No. of Beats.	
60	56	8	51	7	60	17	6	289	Fourth wheel seconds with seventeen teeth in scape wheel.
64	60	8	50	8	60	17	6	283 full	
64	60	8	51	8	60	17	6	289	
75	56	10	68	7	60	17	8	289	
80	60	10	50	8	60	17	6	283 full	
75	64	10	50	8	60	17	6	283 full	
75	68	10	68	8	60	17	8	289	
80	75	10	68	10	60	17	8	289	
60	72	6	60	12	60		6	300	Third wheel and patent second trains.
60	60	6	60	10	60		6	300	
60	48	6	60	8	60		6	300	
48	60	6	60	8	60		6	300	
48	60	6	54	8	60		6	270	
60	72	6	54	12	60		6	270	
48	60	6	48	8	60		6	240	
60	60	6	54	10	60		6	270	
60	72	6	48	12	60		6	240	
48	60	6	48	10	60		6	240	

American Watch.

64	60	8	64	8	60	15	7	300

Trial Watch.

80	75	10	80	10	60	15	8	300

ON TEMPERING.

No part of his trade gives the self-instructed watchmaker more trouble than the acquirement of an ability to temper, as they should be, his various tools and pieces of machinery; in fact a whole life devoted to experiments and study touching this department, would not be likely to attain the desired end. And yet all the processes employed are so amazingly simple as to lead one to wonder, when he understands them, *why* he did not know all about them before.

TO TEMPER BRASS, OR TO DRAW ITS TEMPER.

Brass is rendered hard by hammering or rolling, therefore when you make a thing of brass, necessary to be in temper, you must prepare the material before shaping the article. Temper may be drawn from brass by heating it to a cherry red, and then simply plunging it into water, the same as though you were going to temper steel.

TO TEMPER DRILLS.

Select none but the finest and best steel for your drills. In making them never heat higher than a cherry red, and always hammer till nearly cold. Do all your hammering in one way, for if, after you have flattened your piece out, you attempt to hammer it back to a square or a round, you

spoil it. When your drill is in proper shape heat it to a cherry red, and thrust it into a piece of resin, or into quicksilver.

TO TEMPER GRAVERS.

Gravers and other instruments larger than drills, may be tempered in quicksilver as above; or you may use lead instead of quicksilver. Cut down into the lead half an inch; then, having heated your instrument to a light cherry red, press it firmly into the cut. The lead will melt around it, and an excellent temper will be imparted.

TO TEMPER CASE SPRINGS.

Having fitted the spring into the case according to your liking, temper it hard by heating and plunging into water. Next polish the small end so that you may be able to see when the color changes; lay it on a piece of copper or brass plate, and hold the plate over your lamp, with the blaze directly under the largest part of the spring. Watch the polished part of the steel closely, and when you see it turn blue, remove the plate from the lamp, letting all cool gradually together. When cool enough to handle, polish the end of the spring again, place it on the plate and hold over the lamp as before. The third bluing of the polished end will leave the spring in proper temper. Any steel article to which you desire to give a spring temper may be treated in the same way.

Another process is to temper the spring as in the first instance; then put it into a small iron ladle, cover it with linseed oil and hold over a lamp till the oil takes fire. Remove the ladle, but let the oil continue to burn until nearly all consumed, when blow out, re-cover with oil, and hold over the lamp as before. The third burning out of the oil will leave the spring in the right temper.

TO TEMPER CLICKS, RATCHETS, ETC.

Clicks, ratchets, or other steel articles requiring a similar degree of hardness, should be tempered in mercurial ointment. The process consists in simply heating to a cherry red and plunging into the ointment. No other mode will combine toughness and hardness to such an extent.

TO DRAW THE TEMPER FROM DELICATE STEEL PIECES WITHOUT SPRINGING THEM.

Place the articles from which you desire to draw the temper into a common iron clock key. Fill around it with brass or iron filings, and then plug up the open end with a steel, iron, or brass plug, made to fit closely. Take the handle of the key with your pliers and hold its pipe into the blaze of a lamp till nearly hot, then let it cool gradually. When sufficiently cold to handle, remove the plug, and you will find the article with its temper fully drawn, but in all other respects just as it was before.

You will understand the reason for having the article thus plugged up while passing it through the heating and cooling process, when I tell you that springing always results from the action of changeable currents of atmosphere. The temper may be drawn from cylinders, staffs, pinions, or any other delicate pieces with perfect safety by this mode.

TO TEMPER STAFFS, CYLINDERS, OR PINIONS, WITHOUT SPRINGING THEM.

Prepare the articles as in preceding process, using a steel plug. Having heated the key-pipe to a cherry red, plunge it into water; then polish the end of your steel plug, place the key upon a plate of brass or copper, and

hold it over your lamp with the blaze immediately under the pipe till the polished part becomes blue. Let it cool gradually, then polish again. Blue and cool a second time, and the work will be done.

TO DRAW THE TEMPER FROM PART OF A SMALL STEEL ARTICLE.

Hold the part from which you wish to draw the temper, with a pair of tweezers, and with your blow-pipe direct the flame upon them — not the article — till sufficient heat is communicated to the article to produce the desired effect.

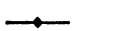
TO BLUE SCREWS EVENLY.

Take an old watch-barrel and drill as many holes into the head of it as you desire to blue screws at a time. Fill it about one fourth full of brass or iron filings, put in the head, and then fit a wire, long enough to bend over for a handle, into the arbor holes — head of the barrel upwards. Brighten the heads of your screws, set them, point downwards, into the holes already drilled, and expose the bottom of the barrel to your lamp till the screws assume the color you wish.

TO REMOVE BLUING FROM STEEL.

Immerse in a pickle composed of equal parts muriatic acid and elixir vitriol. Rinse in pure water and dry in tissue paper.

ON MILLS, BROACHES, FILES, AND BURNISHERS.



YOUR diamond mills, diamond broaches, and diamond files you can generally buy ready made to suit, though instances may occur in which you will require them of a peculiar size and shape, not to be had of the dealers. It is, therefore, best to know how to prepare them.

To make these articles diamond dust is necessary. This you can buy in most of the large cities ready prepared. It is not a costly article; one dollar's worth will last you a long time.

TO MAKE A DIAMOND MILL.

Make a plain brass wheel about two inches in diameter, and arrange it to work to your foot-lathe. Place it flat on some solid substance, and having oiled its face, sprinkle it thinly with coarse diamond dust. With a smooth hammer then tap it lightly till the diamond dust is thoroughly driven into the brass. The brass will bur around it and hold it securely in place. The oil is used to prevent the dust from bounding off while undergoing the process of hammering.

TO MAKE DIAMOND BROACHES.

Make your broaches of brass the size and shape you desire; then, having oiled them slightly, roll their points into fine diamond dust till entirely covered. Hold them then on the face of your anvil and tap with a light hammer till the grains disappear in the brass. Great caution will be necessary in this operation. Do not tap heavy enough to flatten the broach. Very light blows are all that will be required; the grains will be driven in much sooner than one would imagine.

TO MAKE POLISHING BROACHES.

These are usually made of ivory, and used with diamond dust, loose, instead of having been driven in. You oil the broach lightly, dip it into the finest diamond dust and proceed to work it into the jewel the same as you do the brass broach.

TO MAKE DIAMOND FILES.

Shape your file of brass, and charge with diamond dust, as in case of the mill. Grade the dust in accordance with the coarse or fine character of the file desired.

TO MAKE PIVOT FILES.

Dress up a piece of wood, file fashion, about an inch broad, and glue a piece of fine emery paper upon it. Shape your file then, as you wish it, of the best cast steel, and before tempering pass your emery paper heavily across it several times, diagonally. Temper by heating to a cherry red, and plunging into linseed oil. Old worn pivot files may be dressed over and made new by this process. At

first thought one would be led to regard them too slightly cut to work well; but not so. They dress a pivot more rapidly than any other file.

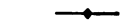
TO MAKE BURNISHERS.

Proceed the same as in making pivot files, with the exception that you are to use fine flour of emery on a slip of oiled brass or copper, instead of the emery paper. Burnishers which have become too smooth may be improved vastly with the flour of emery as above without drawing the temper.

TO PREPARE A BURNISHER FOR POLISHING.

Melt a little beeswax on the face of your burnisher. Its effect then, on brass or other finer metals, will be equal to the best buff. A small burnisher prepared in this way is the very thing with which to polish up watch wheels. Rest them on a piece of pith while polishing.

NECESSARY TOOLS, ETC.



Small bench vise.
Pin vise.
Cut nippers and pliers.
Tweezers.
Large and small screw-drivers.
Several fine brushes.
Peg wood.
Watch oil.
Wood cup, for holding the cleaned pieces.
Glass covers.
Bench knife.
Eye-glass.
Prepared chalk or bone.
Elder pith.
Fine chamois skin.
Oil cup.
Tissue and bench paper.
Bench apron.
Pin file.
Burnisher.
Oiler — nicely made.
These can be obtained of dealers in watch materials.

CLEANING AND REPAIRING CLOCKS.

473318

CLEANING AND REPAIRING AMERICAN CLOCKS.

TO CLEAN A CLOCK.

TAKE the movement of a clock to pieces. Brush the wheels and pinions thoroughly with a stiff, coarse brush; also the plates into which the trains work. Clean the pivots by turning in a piece of cotton cloth held tightly between your thumb and finger. The pivot holes in the plates are generally cleansed by a strip of cloth or a soft cord drawn tightly through them. If you use two cords, the first one slightly oiled, and the next dry to clean the oil out, all the better.

TO BUSH.

The holes through which the great arbors, or winding axles work, are the only ones that usually require bushing. When they have become too much worn the great wheel on the axle before named strikes too deeply into the pinions above it, and stops the clock. To remedy this, "bushing" is necessary. The most common way of doing it is to drive a steel point or punch into the plate just above the axle hole, thus forcing the brass downward until the hole is reduced to its original size.

TO REMEDY WORN PINIONS.

Turn the leaves or rollers so the worn places upon them will be towards the arbor or shaft, and fasten them in that position. If they are "rolling pinions," and you cannot secure them otherwise, you had better do it with a little soft solder.

TO OIL PROPERLY.

Oil only, and very lightly, the pallets of the verge, the steel pin upon which the verge works, and the point where the loop of the verge wire works over the pendulum wire. Use none but the best watch oil.

TO MAKE THE CLOCK STRIKE CORRECTLY.

If not very cautious in putting up your clock you will get some of the striking-train wheels in wrong, and thus produce a derangement in the striking. If this should happen, pry the plates apart on the striking side, slip the pivots of the upper wheels out, and having disconnected them from the train, turn them part around and put them back. If still not right, repeat the experiment. A few efforts at most will get them to working properly.

A DEFECT TO LOOK AFTER.

Always examine the pendulum wire at the point where the loop of the verge wire works over it. You will generally find a small notch, or at least a rough place, worn there. Dress it out perfectly smooth, or your clock will not be likely to work well. Small as this defect may seem, it stops a large number of clocks.

TABLE

SHOWING THE TIME AT 114 DIFFERENT PLACES WHEN IT IS 12 O'CLOCK, MEAN NOON, AT BOSTON, MASS.

	H.	M.	S.
Albany, N. Y.	11	49	15
Alexandria, Egypt.	6	43	46
Annapolis, Md.	11	38	18
Astoria, Oregon.	8	29	36
Augusta, Me.	12	04	54
Baltimore, Md.	11	37	47
Bangor, Me.	12	09	06
Berlin, Prus.	5	37	49
Boston, Mass.	12	00	00
Brattleboro', Vt.	11	54	06
Bremen, Ger.	5	19	26
Brooklyn, N. Y.	11	48	20
Buffalo, N. Y.	11	28	34
Canton, China.	12	17	20
Cambridge, Mass.	11	59	44
Cape Town, C. G. H.	5	58	10
Charleston, S. C.	11	24	32
Chicago, Ill.	10	53	43
Cincinnati, Ohio.	11	06	16
Cleveland, Ohio.	11	16	50
Clinton, N. Y.	11	42	37
Columbus, Ohio.	11	12	02
Concord, N. H.	11	58	18
Constantinople,	6	40	10
Detroit, Mich.	11	12	04
Dover, N. H.	12	00	38
Dublin, Ireland.	4	18	52
Eastport, Me.	12	16	30
Edinburgh, Scot.	4	31	30
Fall River, Mass.	11	59	46
Frankfort, Ky.	11	05	34
Geneva, Swit.	5	08	50
Gibraltar, Spain.	4	22	50
Gloucester, Mass.	12	01	35
Greenwich, Eng.	4	44	14
Halifax, N. S.	12	29	47
Hallowell. Me.	12	04	54
Harrisburgh, Pa.	11	36	54
Hartford, Conn.	11	53	31
Havana, Cuba.	11	14	43
Haverhill, Mass.	11	59	54
Havre, France.	4	44	39
Honolulu, S. Is.	6	12	46
Jeddo, Japan.	2	04	14
Key West, Fla.	11	17	04
Leavenworth, Kan.	10	25	18
Lexington, Ky.	11	07	02
Lima, Peru.	11	35	43
Liverpool, Eng.	4	32	13
Lockport, N. Y.	11	29	10
London, Eng.	4	43	50
Louisville, Ky.	11	02	14
Lowell, Mass.	11	58	58
Melbourne, N. S. W.	2	24	07
Memphis, Tenn.	10	43	42
Mexico City, Mex.	10	07	52
Milwaukie, Wis.	10	52	37
Mobile, Ala.	10	52	08
Montpelier, Vt.	11	53	50
Montreal, C. E.	11	50	02
Nantucket, Mass.	12	03	52
Nashua, N. H.	11	58	28
Newark, N. J.	11	47	34
New Bedford, Ms.	12	00	32
Newburyport, Ms.	12	00	46
New Haven, Conn.	11	52	32
N. London, Conn.	11	55	54
New Orleans, La.	10	44	14
Newport, R. I.	11	59	00
New York City,	11	48	14
Niagara Falls, N. Y.	11	27	58
Norfolk, Va.	11	39	00
Northampton, Ms.	11	53	44
Omaha City, Ne.	10	20	18
Oswego, N. Y.	11	37	50
Panama, C. A.	11	26	17
Paris, France.	4	53	35
Philadelphia, Pa.	11	43	34
Pike's Peak, Kan.	9	44	14
Pittsburgh, Pa.	11	24	06
Portland, Me.	12	03	16
Portsmouth, N. H.	12	01	11
Providence, R. I.	11	58	39
Provincetown, Ms.	12	04	02
Quebec, C. E.	11	59	25
Queenstown, Ire.	4	11	14
Raleigh, N. C.	11	29	02
Richmond, Va.	11	34	24
Rio Janeiro, Brazil.	1	51	38
Rochester, N. Y.	11	32	50
Rome, Italy.	5	34	08
Sacramento, Cal.	8	38	23
Salem, Mass.	12	00	40
Salt Lake City, Ut.	9	15	50
San Francisco, Cal.	8	34	27
Saratoga, N. Y.	11	49	14
Savannah, Ga.	11	19	53
Southampton, Eng.	4	38	38
Springfield, Mass.	11	53	51
St. Louis, Mo.	10	43	13
St. Petersburgh,	6	45	28
Stockholm, Swed.	5	56	29
Syracuse, N. Y.	11	39	26
Tallahassee, Fla.	11	05	50
Taunton, Mass.	11	59	50
Toronto, C. W.	11	26	41
Trenton, N. J.	11	45	38
Utica, N. Y.	11	43	22
Vienna, Aust.	5	49	46
Washington, D. C.	11	36	02
West Point, N. Y.	11	48	24
Wheeling, Va.	11	21	26
Woodstock, Vt.	11	54	10
Worcester, Mass.	11	57	01